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A MODEL OF TACTICAL BATTLE RHYTHM

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Abstract

Joint Battle Rhythm: The timing and scheduled presentation of situation reports, briefings, formal collaborative sessions, and other required actions during planning and execution. *"Deployment Planning Using Collaboration," A Handbook Supporting Collaborative Planning. JFCOM, JDPO, 2002*

Tactical Battle Rhythm: "The U.S. Marine Corps MAGTF Staff Planning Program (MSTP) defines battle rhythm as the 'process where the commander and his staff synchronize the daily operating tempo within the planning, decision, execution and assessment (PDE&A) cycle to allow the commander to make timely decisions…' Some of the planning and operating cycles that influence the battle rhythm of the command include intelligence collection, targeting, air tasking orders (ATO), reconnaissance tasking, and the bomb battle damage assessment collection cycles. This battle rhythm is the commander's battle rhythm. It is his 'plan of the day.'" *Marine Corps Gazette, Vol 8, February 200, pp 34-36*

The purpose of battle rhythm management is the maintenance of synchronized activity and process among distributed warfighters. It is most critical in rapidly evolving situations or in highly distributed operations. Successful battle rhythm implies the synergism of procedures, processes, technologies, individual activities and collective actions at warfighter, staff level, command node, and unit levels in order to facilitate military operations. The concept is ubiquitous in daily military operations (particularly at the operational level of command), but little exists to define it at the tactical level or substantiate its existence in the experimental or analytical literature. Like art, we know it when we see it, and often see it differently, given our individual perspectives. Moreover, given the proliferation of distributed, virtual operations in virtual command centers (those existing exclusively within and across information networks), there appears to be a curious lack of knowledge regarding the establishment and maintenance of battle rhythm in virtual command environments. There is a need to establish a common referent, a model of tactical battle rhythm, in order to discover the methods best suited to "command and control" it.

Introduction. "Network-centric warfare" is a reality [1]. The Office of the Secretary of Defense has launched "Network Centric Enterprise Services." This electronic, grid-dependent, concept which promotes a command and control element exploiting 21st century technologies will require that we develop innovative methods for maintaining command and control of distributed and multi-echelon service personnel in the successful completion of mission objectives. If the battlefield has turned electronic, then so too must our methods for synchronizing the actions of thousands of warfighters. Current methods for distributing "information" (e.g., of the dynamically evolving situation)

among services and echelons has led to an increased susceptibility to disjointed timelines between various levels of command and decision makers who are not fully aware of, nor are available at, critical decision points, leading to confusion and lack of agility. Distributed team decision making can become a victim to the technologies that it relies upon [2].

We propose that the judicious employment of *collaborative technologies* among distributed warfighters is one strategy for managing tactical battle rhythm. The collaborative technologies [3] include:

- *The asynchronous tools* represented by e-mail, discussion groups, file sharing, news servers and similar software products which provide the basis for persistent virtual workspaces.

- *The synchronous tools* where interaction between people and specialized hardware and software facilitates handling data and representing information. Person-to-person communication is supported by the ability to share, modify and collaboratively create data and information at the same time. These are dominated by video/audio teleconferencing, instant messaging, and chatrooms.

We assert that the increasing reliance on collaborative technologies will lead to successful management of tactical battle rhythm. However, we need a way to model the tactical battle rhythm in order to predict the most effective times to use collaborative tools.

Model of Tactical Battle Rhythm. We propose a conceptual framework of "tactical battle rhythm" (TBR) and present a model of "real world" TBR in the context of a notional humanitarian assistance operation [4]. The focus of our model is at the battalion/squadron/combat/service support group level, in an attempt to explore the *execution* phase of warfighter activities, the activities that define the tactical level. Through this lens, we will provide one perspective on the use of collaborative technologies to enhance the synchronization of distributed activities that are the hallmark of tactical battle rhythm.

TBR is not only a function of the predictable requirements both imposed and indirectly attributed to the operational and tactical command staff, but it reflects and adapts to the unpredictable, often chaotic external variables (Mission, Enemy, Terrain, Weather, etc.) while simultaneously providing feedback to the commander in order to instantiate course corrections and synchronized movement forward. TBR begins with the commander's *planned* battle rhythm which is transposed into an *execution* battle rhythm. We propose that this transition is enabled and enhanced by the judicious use of synchronous and asynchronous collaboration technologies, enabling timely feedback leading to appropriate battle responses. An ideal collaborative tool set, coupled with an extensive sensor (human and technological) and network grid, has the potential to transform battlefield information flow and allow commanders to "out-react" their adversaries by getting inside of the enemy's information processing OODA (observe-orient-decide-act) loops.

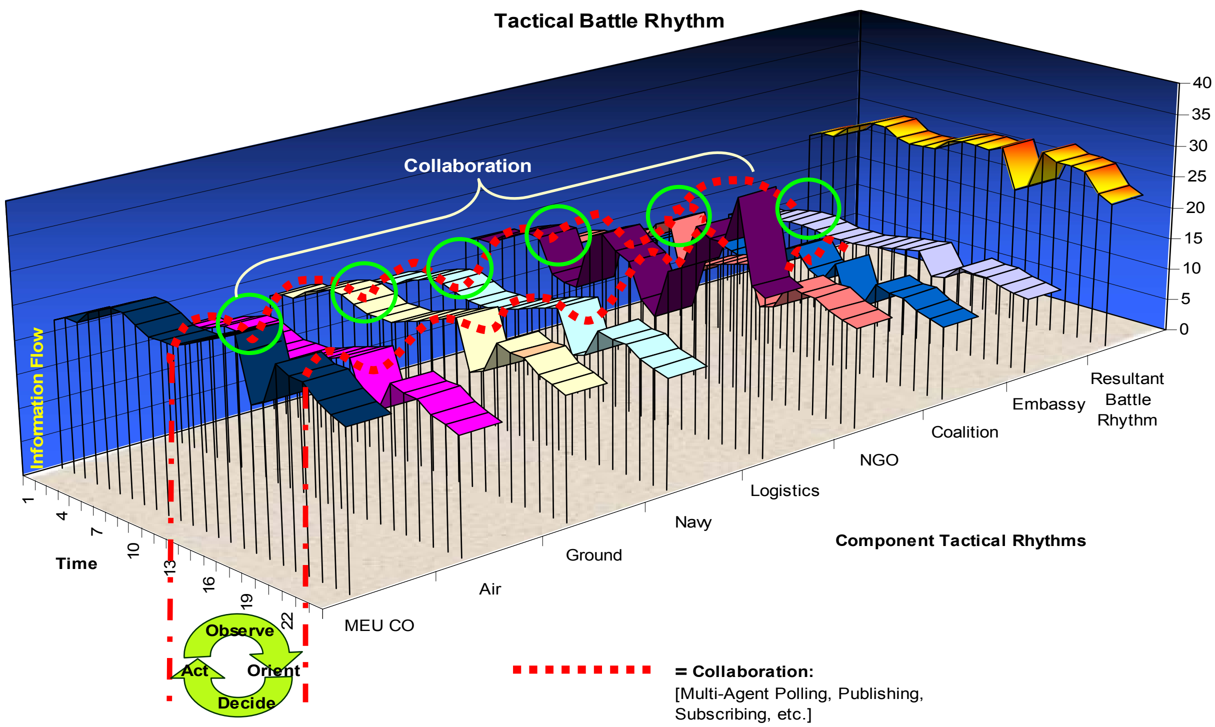
At present, most, if not all, formal discussions of battle rhythm in doctrinal literature are centered on the staff level of operational command and control. Successful battle rhythm at this high level is exclusively characterized as the disciplined flow of information focused through time. Information transfer at the Destroyer Squadron, Marine Expeditionary Force (MEF), ship, or Corps level is driven primarily by the operational planning/mission order requirements of the Combatant Commander—in direct support of the staff battle rhythm. This battle rhythm is achieved when staffs are able to act as a synchronized, coherent, and predictive whole. Elaborate matrices of events and times are constructed to prioritize the planning, reports, and information management flows associated with numerous recurring (predictable) and non-recurring (emergent) staff HQ activities. Though this paradigm requires information flow and synchronization with the major tactical-level subordinate commands, staff action is not the only factor that establishes battle rhythm at the tactical level. It is the actual *execution* of the mission, with all of its inherent uncertainties and unique requirements that generate the baseline tactical battle rhythm. It is our contention that collaborative technologies provide either the coalescing function, and/or forcing function; it provides the unique, timely venue for continual recalibration of tactical activities across a distributed battlefield.

A proposed depiction of tactical battle rhythm is represented in Figure 1. This concept can be visualized through use of a waveform metaphorical construct. In this context, the "carrier signal" (Group Staff/MEF commander's battle rhythm) produces a primary "driving frequency" to which all subordinate commands must synchronize (information requirements requiring information flow "care and feeding"). The convergence of individual battle rhythm wave forms ultimately generates an operation's TBR. This resultant TBR evolves out of the information requirements of the unfolding operation. The goal is to synergize command processes defining the TBR through use of collaborative methods and technologies (applications, intelligent agents, network architectures, etc) to provide an instantaneous environment where information flow is distributed and synchronized across the information grid.

The three dimensional notional tactical battle rhythm information grid depicted in Fig. 1 is bounded on the X-axis by the component Tactical Operation Centers, or TOCs. This is a notional term that represents a primary heterogeneous network node responsible for specific mission-related information flow. This abstract TOC network forms the baseline network structure of the tactical information grid. The entities representing the TOCs in this example are the Landing Force Operations Control Center (or Marine Expeditionary Unit CO [Commanding Officer] TOC), the Tactical Air Coordination Center Afloat (Air TOC), the MEU Ground Combat Element (GCE) battalion combat operations center (Ground TOC), the Naval tactical command center afloat (Navy TOC), Logistics Operation Control Center (Log TOC), Non-Governmental Organization (NGO) operation center (NGO TOC), the coalition TOC, and the US Embassy operations center (Embassy TOC). The Y-axis represents the evolving mission time. Inherent to this time line is the mission commander's (MEU CO's) Observe, Orient, Decision, Act loop, or "OODA Loop." Information flows exchanged between TOCs provide direct and indirect feedback directly to the OODA loop. The Z-axis represents the amount of information flow per entity at any given time. This information flow is dynamic and is directly related to the

information requested from the entity as well as the individual TOC's information requirements. The commander's OODA loop, in conjunction with the run-time uncertainties of the mission, defines each TOC's unique characteristic information battle rhythm.

Figure 1. A Notional Tactical Battle Rhythm as a Waveform Construct.



The key aspect of the TBR in Fig 1 is that information is shared among all heterogeneous nodes rather than just between the MEU command TOC and all subordinate entities. It is this network-centric information sharing architecture, enabled by collaboration events, which lead to a successful TBR. A successful TBR is defined by a shared situational awareness of activities and outcomes by all relevant parties. Shared situational awareness is facilitated through the employment of various collaborative technologies that allow for continuous communication and exchange of information between heterogeneous nodes throughout the information grid. In the past, terse radio-based voice exchanges, couriered messages, telephone conferences, facsimile machines, and personal face-to-face conversations provided the coordinative and collaborative venues that drove the TBR. Today, email, instant messages, chatroom exchanges, as well as desk-top and room-based video-teleconferences provide even more pathways in which units pass current and intended activity status. Intelligent agent technology, incubating over the past two decade, is slowly beginning to appear as another supporting venue. Agents are the autonomous software mechanisms that collect and distribute the information. They also

manage information requirements through a variety of methodologies. Some of these methods include polling, publishing, logging, subscribing, and alarming, all of which electronically replicate traditional mechanisms for sharing information among distributed warfighters.

Collaborative Events as Information Exchange Types. The synchronization moments or collaborative events (green circles in Fig 1) are moments in time where information is exchanged between grid entities. The mechanisms that comprise the synchronization structure are poll, publish, alarm, and subscribe [4]. *Polling* is an information pull technique whereby nodes continually probe for desired information and "extract" it, once found. In the traditional method, effective warfighters would contact their coordinating elements and ask for relevant information. Today, it is a task performed by increasingly effective intelligent agents. *Publishing* information to the TOCs is a push method used to distribute updated or requested information to the grid. Traditionally, this was accomplished by posting the plan of the day or through the defense messaging system. *Alarming* is another form of information push but it results from specific feedback to a predetermined condition. This used to be accomplished by astute warfighters who had the time and means to "manually" warn their brethren. Nodes that *subscribe* to information receive services available on the tactical information grid that facilitate the planning, execution, decision, and assessment cycle. This too, traditionally, was a function of several formal means of communication among units, dependent upon paper and telephone venues.

True collaboration at the tactical level can only be realized through a network-centric warfare architecture that provides consistent connectivity, and a variety of collaborative technologies to support various means of information sharing. The future would provide a warfighting environment that ensures all nodes in the battle rhythm network are connected and information is instantaneous and ubiquitous, provided a user has the appropriate access. This framework could eventually eliminate the formal doctrinal (and Powerpoint® dependent) situation report (SITREP), logistics report s (LOGREP), personnel report (PERSREP) submissions, because each node has awareness of all other nodes and information is dynamically distributed throughout the network.

Thus, the resultant tactical rhythm is bounded by information requirements. At the tactical level, predicted, formal staff action (based on formal doctrinal information exchanges) is supplanted by dynamic shared situational awareness and collaboration that results in immediate mutual adjustment and synergy.

Collaborative Computing Architectures. To support this model of information sharing, differing collaborative computing architectures must be examined and exploited. The two most popular architectures are comprised of the *client-server* and the *peer-to-peer* models. Collaborative applications are built based on these two models.
<u>Client/server applications</u> enable communication between clients but only after they connect to the server, which acts as middleman, keeping the master copy of all the information, running nearly all the application logic, and downloading the results to the client.

Peer-to-peer (P2P) applications [5] require the application logic and information reside almost always on the client, which communicates directly to other clients without server mediation. Peer-to-peer is also called decentralized computing but that doesn't entirely exclude the use of the servers, particularly for discovery of users.

We believe that a hybrid architecture could best serve the demands of TBR delineated in Figure 1. For example, where web services are necessary, so too is a client-server architecture. However, where (chat) messaging and file sharing are paramount, then a P2P architecture would provide the most efficient and robust computing environment for immediate information exchange. (P2P architectures do not have a single point of failure, the server, as do client-server architectures.) Thus, the nature of the warfighter activity in support of TBR would demand specific network architectures in support of that activity.

Conclusion. It is our contention that a tactical battle rhythm model, as provided in this paper, could provide a referent for discussions and predictions for optimizing computing architecture and tool employment. For example, in a distributed collaborative battle-execution-monitoring experiment conducted by the Naval Postgraduate School, using a model of tactical battle rhythm to delineate the phases of the scenario enhanced their ability to find the collaboration events that marked productive exchanges of information among distributed participants [4]. The investigators found communication exchange spikes (in this case, using chat) during particular phases of the experimental timeline. An analysis of one of these chat spikes resulted in the categorizing of the exchanges as (1) 61% request-response, (2) 29% publish-synchronization, (3) 3% alarm, or (4) 7% other.

It would not be a far leap to predict that a P2P model would be most efficient for request-response exchanges, while a client-server architecture would be most proficient in the publish-synchronization and alarm phases. An experiment with specific predictions regarding shared situation awareness based on computing architecture and collaborative tool employment would be an interesting next step in our understanding of and prediction of effective tactical battle rhythm management.

Future systems (from software to network) must be facile in providing the environment that best suit the warfighter's needs and provide it on demand. It is hoped that this model of TBR will provide a starting point for research on the effectiveness of distributed collaborative exchanges, based on collaborative technology use. It is also hoped that it will provide a method for determining the optimal computing architecture for particular collaboration events. This combination, optimal computing architecture and appropriate collaborative tool use, as a function of collaborative event needs, will provide the edge that will power command and control in the 21st century.

References.

1. Alberts, David, Garstka, John J., and Stein, Frederick P. *Network Centric Warfare: Developing and Leveraging Information Superiority (2nd Ed.).* Washington, D.C.: CCRP Publication Series, 1999.

2. Duffy, LorRaine. "Team Decision Making and Technology." In N.J. Castellan, Jr. (Ed.) *Individual and Group Decision Making: Current Issues*. Hillsdale, NJ: Lawrence Erlbaum Associates. 1993. 247-266.
3. Duffy, LorRaine and Ceruti, Marion. "Collaboration Technology for Joint and Naval Applications: Past Progress and Future Directions." In Waleed Smari and William McQuay (Eds.) *2004 International Symposium on Collaborative Technologies and Systems*. San Diego, CA: The Society for Modeling and Simulation International, Vol 36, No 1, 2004, pp 102-108.
4. Bordetsky, Alex, Bach, Eric, Blazevich, Ryan, Oros, Carl, Pugh, Todd, Schumann, Axel, Ahciarliu, Cantemir and Montehermoso, Ron. *An Analysis of the Impact of Modern Collaborative Technology on Battle Rhythm at the Tactical Level.* White paper. Naval Postgraduate School, September, 2003.
5. Leuf, B. *Peer to Peer: Collaboration and Sharing Over the Internet*. Boston, MA: Addison-Wesley. 2002.

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A Model of Tactical Battle Rhythm

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Definition of Battle Rhythm

Joint Battle Rhythm: The timing and scheduled presentation of situation reports, briefings, formal collaborative sessions, and other required actions during planning and execution.

"Deployment Planning Using Collaboration," A Handbook Supporting Collaborative Planning. JFCOM, JDPO, 2002

Tactical Battle Rhythm: "The U.S. Marine Corps MAGTF Staff Planning Program (MSTP) defines battle rhythm as the 'process where the commander and his staff synchronize the daily operating tempo within the planning, decision, execution and assessment (PDE&A) cycle to allow the commander to make timely decisions…' Some of the planning and operating cycles that influence the battle rhythm of the command include intelligence collection, targeting, air tasking orders (ATO), reconnaissance tasking, and the bomb battle damage assessment collection cycles. This battle rhythm is the commander's battle rhythm. It is his 'plan of the day.

'" *Marine Corps Gazette, Vol 8, February 200, pp 34-36*

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Successful Battle Rhythm

- Successful battle rhythm implies the synergism of procedures, processes, technologies, individual activities and collective actions at warfighter, staff level, command node, and unit levels in order to facilitate military operations.
- Increasing reliance on collaborative technologies will lead to successful management of tactical battle rhythm

Tactical Battle Rhythm

- TBR begins with the commander’s *planned* battle rhythm which is transposed into an *execution* battle rhythm
- This transition is enabled and enhanced by the judicious use of synchronous and asynchronous collaboration technologies, enabling timely feedback leading to appropriate battle responses.

Collaboration Tools

- *The asynchronous tools* represented by e-mail, discussion groups, file sharing, news servers and similar software products which provide the basis for persistent virtual workspaces.
- *The synchronous tools* where interaction between people and specialized hardware and software facilitates handling data and representing information. Person-to-person communication is supported by the ability to share, modify and collaboratively create data and information at the same time. These are dominated by video/audio teleconferencing, instant messaging, and chatrooms.
- Collaborative technologies provide either the coalescing function, and/or forcing function; it provides the unique, timely venue for continual recalibration of tactical activities across a distributed battlefield

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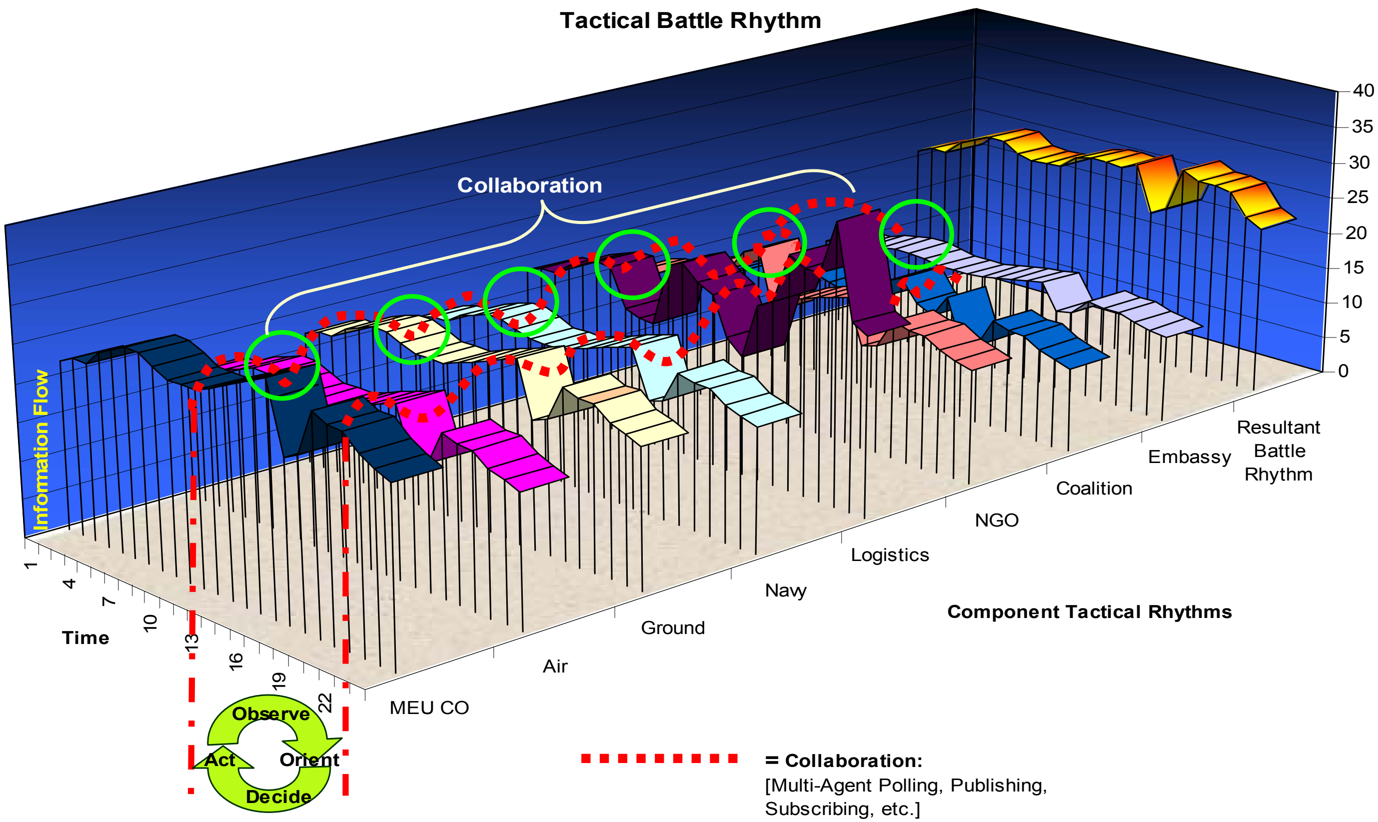
Model of Tactical Battle Rhythm

A Notional Tactical Battle Rhvthm as a Waveform Construct



Collaborative Events

- The synchronization moments or collaborative events are moments in time where information is exchanged between grid entities. The mechanisms that comprise the synchronization structure are poll, publish, alarm, and subscribe
  - *Polling*
  - *Publishing*
  - *Alarming*
  - *Subscribe*

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Collaborative Computing Architectures

- Client/server applications
- Peer-to-peer (P2P) applications
-
- Hybrid applications

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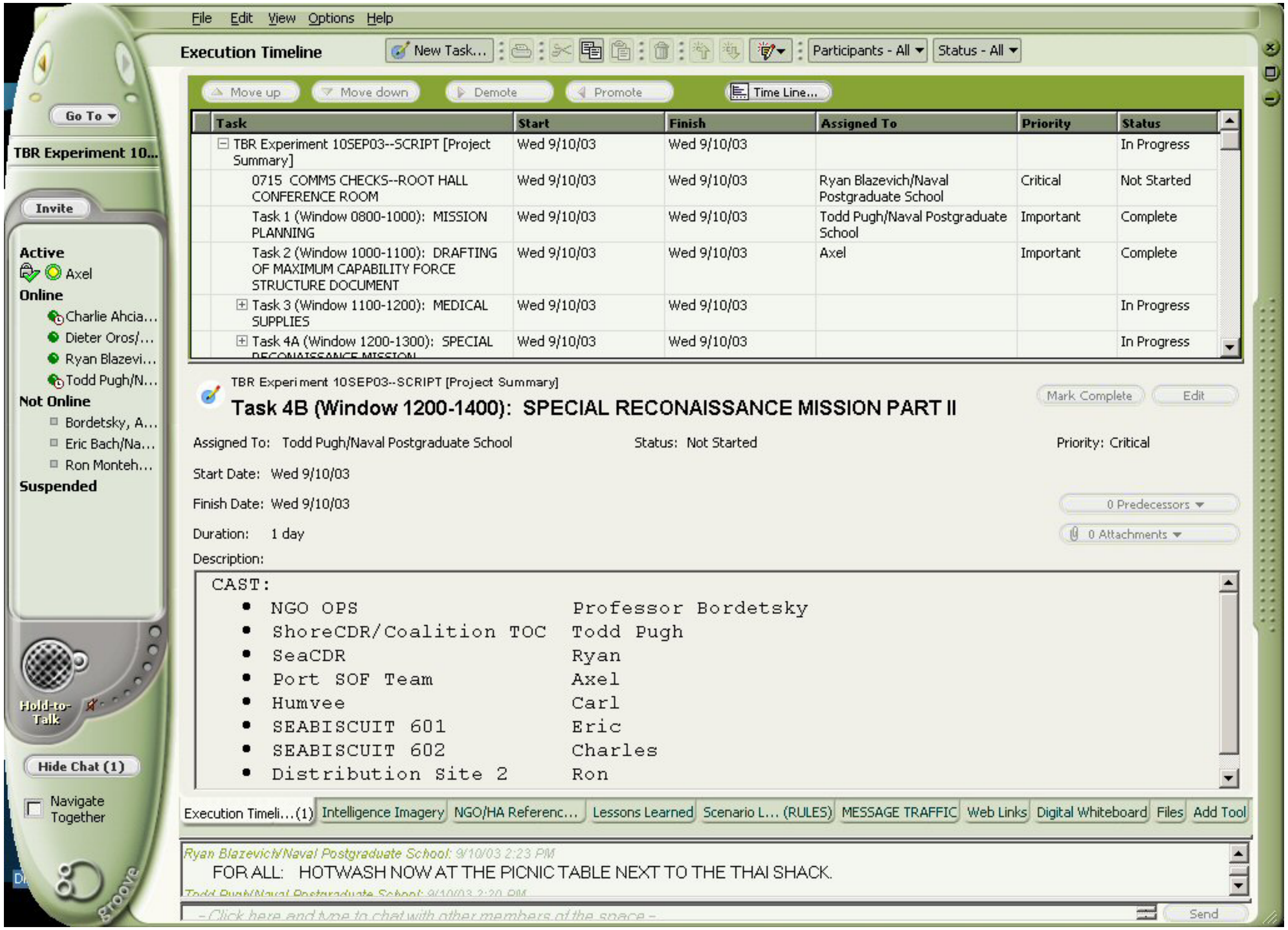
Groove P2P collaborative user interface the participants used during the Tactical Battle Rhythm experiment



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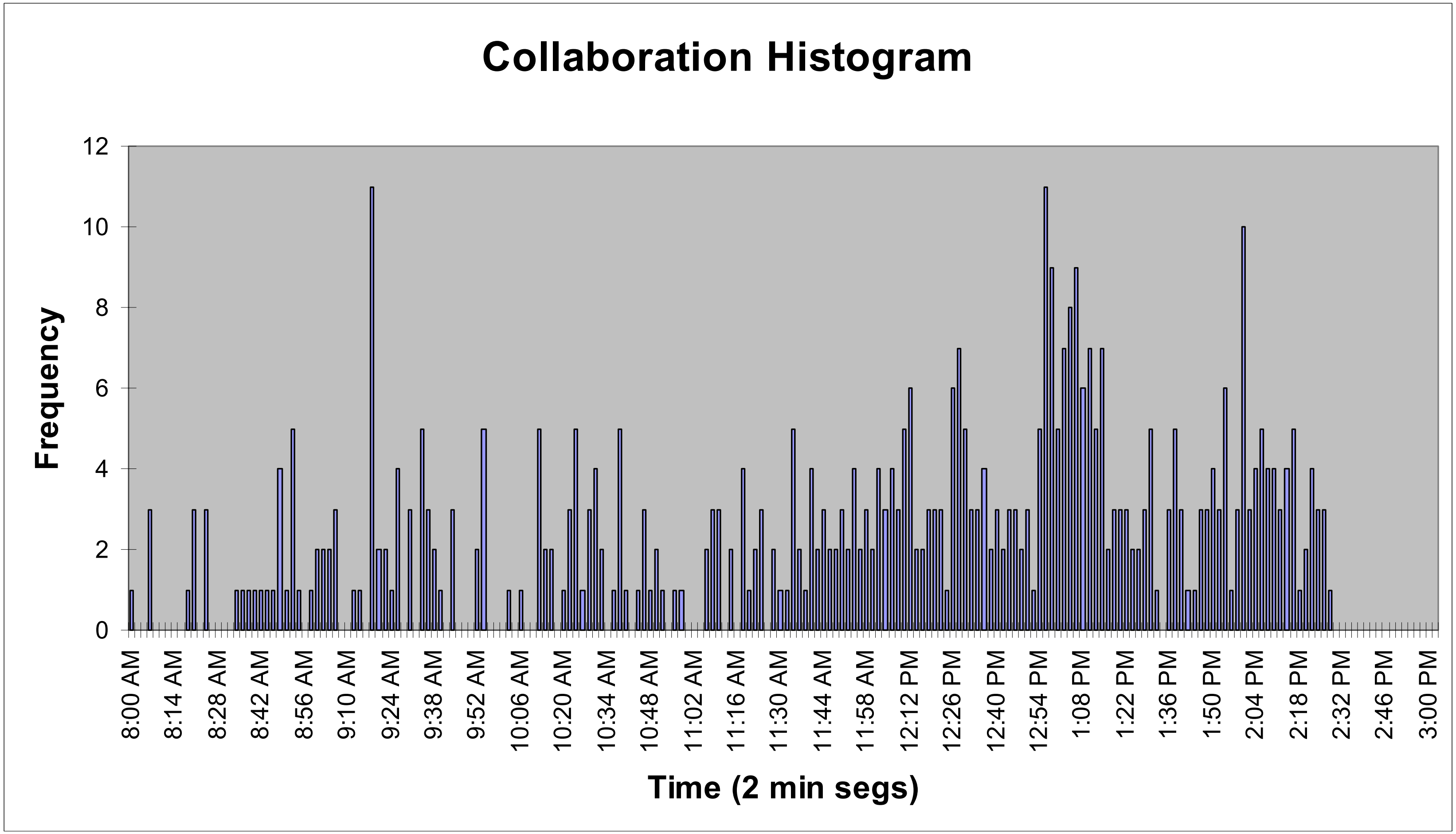
The rhythms inherent in multi-node operations



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Experimental Observations

- By overlaying the experiment timeline onto the distribution of the communication events, a definite pattern emerged with respect to complexity of the scenarios and collaboration.
- Within the experiment, during the period from 12:00 pm to 2:00 pm the most complex scenario was conducted. During this same period, there were 234 discrete communications.
- This comprised 49.4% of the total communications in a period that was just 30.9% of the total time. While there were more participants in the complex scenario, the spike in exchanges was significant.

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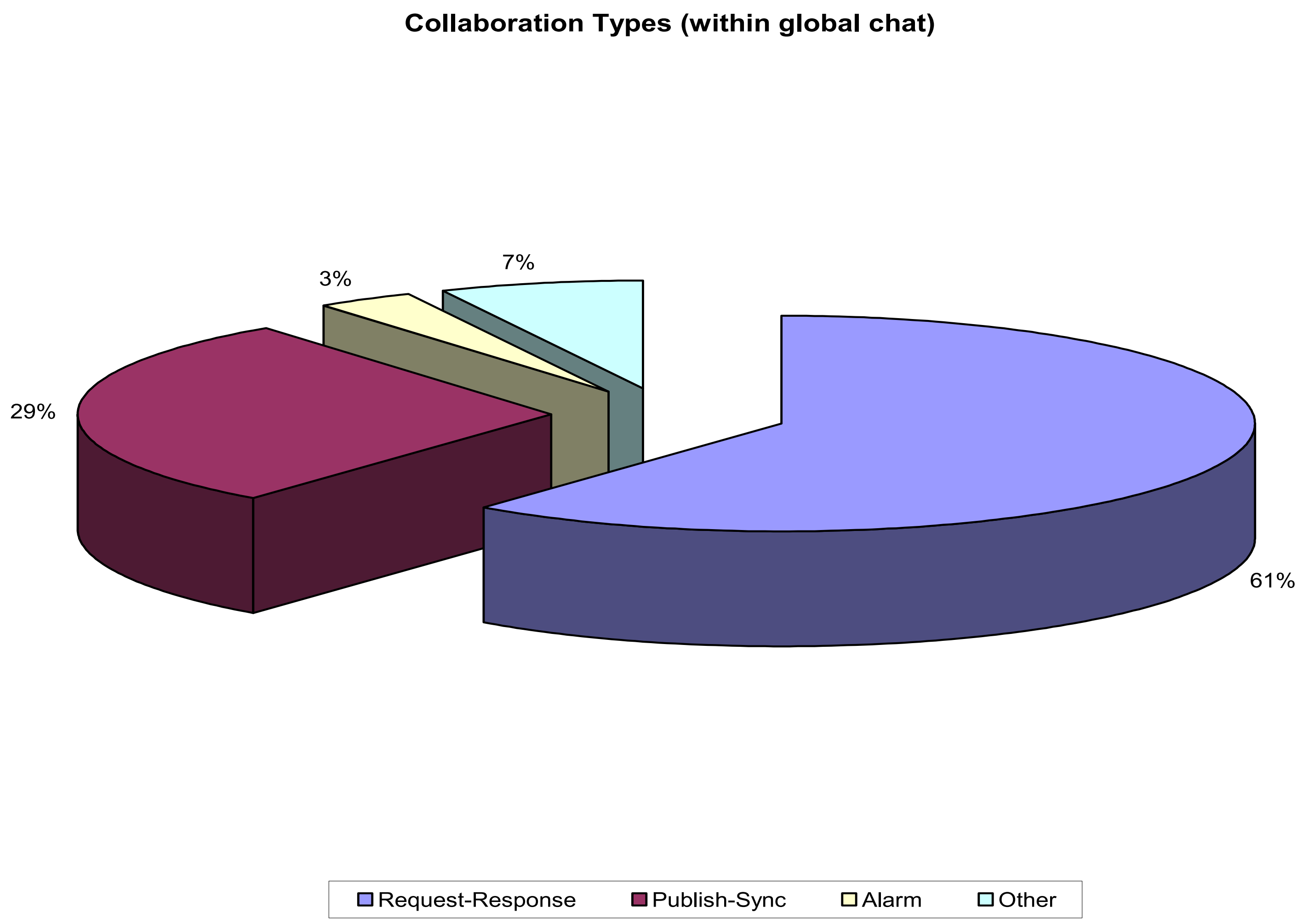
Collaboration chat rhythm: 313 discrete chat posts in the 388 minutes of the experiment.



Experimental Observations

- The request-response category was primarily composed of queries for tasking, direction, and clarification, and the associated answers to those queries.
- The publish-synchronization category included general announcements and situation reports that sought to promote widespread situational awareness without prior prompting.
- The alarm category was made up of broadcasts that were similar to the publish-synchronization items, but with high importance and possible immediate, major impact on overall operations.

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Conclusion

- This model of TBR will provide a starting point for research on the effectiveness of distributed collaborative exchanges
- Provide a method for determining the optimal computing architecture for particular collaboration events